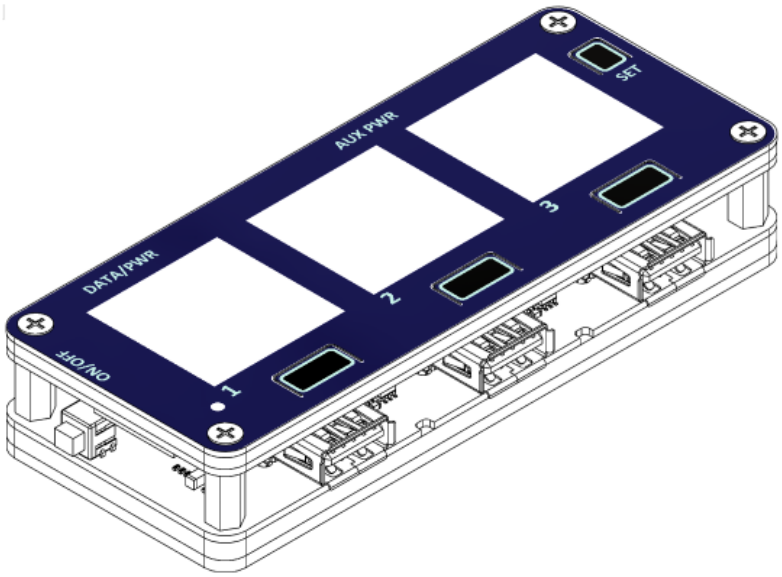
USB Insight Hub

USER MANAUAL



PN: USB-INSIGHT-HUB-A1

Release: v1.0 – September 2025

Aerio Solutions

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1. REGULATORY COMPLIANCE AND SAFETY INFORMATION

WARNINGS:

- This product must be only connected to a USB computer port or external power supply rated at 5.5V DC max.
- The maximum input current is rated to 5A, and each USB Type A port can supply a maximum of 2A at the same voltage provided by DATA/PWR or AUX.
- This product should be operated in a well-ventilated environment.
- Do not expose it to water, moisture or heavy dusty environments.
- Do not expose it to heat from any source; this product is designed to work in normal ambient room temperatures.
- Do not insert any object inside the unit as this may cause damage to the electronic components.
- Avoid placing excessive strain on USB connectors.

COMPLIANCE INFORMATION

USB Insight Hub complies with the relevant provisions of the RoHS Directive for the European Union. In common with all Electrical and Electronic Equipment (EEE) the USB Insight Hub should not be disposed of as household waste. Alternative arrangements may apply in other jurisdictions.

ELECTROMAGNETIC COMPATIBILITY AND OPERATION

This product is in conformity with the protection requirements of EU Council Directive 201/53/EU relating to radio equipment.

This product has been tested and found to comply with the limits for Class B Information Technology Equipment according to the European Standard.

2. FEATURES AND SPECIFICATIONS

Thank you for the purchase of USB Insight Hub, a USB 3.0 hub designed with a set of features that provides power control, monitoring and protection for USB devices and a novel mechanism to show the enumeration assigned by the operating system. In addition, a Wi-Fi enabled web interface and a virtual serial link are available for control and configuration of your USB ports. As an open-sourced project, you can find the relevant information at *github.com/Aeriosolutions/USB-Insight-HUB-Hardware*.

USB Interface

- USB hub supports USB 2.0 lines (Low, Full, and Hi-Speed) as well as USB 3.0 lines (5 Gbps Super-Speed).
- One upstream USB 3.0 Type-C port for data and power (up to 3 A @ 5.5 V).
- Three downstream USB 3.0 Type-A ports.
- Individual USB 2.0 D+/D- control switches for each downstream port.
- Selectable operation as USB 2&3 hub (default), USB 2 only or USB 3 only.

User Interface

- 3x color 1.3-inch TFT displays (240x240), IPS, 170° viewing angle, 250 NITs.
- 3x mechanical push buttons for power and data control and 1x setup button.
- Dedicated latching switch to control device-wide power.
- Remote Web UI provided via Wi-Fi (AP or client) for configuration and control.

Power

- One dedicated USB Type-C connector for auxiliary power up to 5 A @ 5.5 V.
- Dedicated power and energy monitor for current and voltage monitoring on each downstream port.
- Individual switch for power control to each downstream port with hardware current protection up to 2.0 A.
- Software overcurrent protection configurable in 1 mA steps.
- Software Reverse current protection configurable in 1mA steps.
- All data and power inputs and outputs are properly protected against ESD.

Host-Computer Compatibility

- Readily available Windows, Linux, and MacOS drivers for the USB Hub chip and the ESP32-S3 microprocessor.
- USB enumeration extraction agent software for Windows.

Other Features

- Downstream ports are spaced further apart than they are in most hubs.
- Acrylic protection for PCBs and displays.
- Additional STEMMA QT connector to extend functionality.
- 2.4GHz Wi-Fi wireless interface.
- Includes 1-meter USB Type-A to Type-C cable.

Electrical characteristics

- Input voltage: 4.5-5.5VDC
- Idle current consumption: 200mA
- Max. combined input current: 5A
- Max. current for each downstream port: 2A
- Current and voltage resolution: 1mA/1mV (±2%)

Physical characteristics

Size: 11.0 x 4.5 x 2.1 cm / 4.3x1.8x0.8 in
Weight (without USB cable): 80g / 0.18lb

3. QUICK START

1. Connect the USB Cable from the host computer to the DAT/PWR USB C port.
2. Turn ON the unit by pressing the ON/OFF switch. Drivers will be installed automatically.
3. Download UIH Enumeration Extraction Agent from github.com/Aeriosolutions/USB-Insight-HUB/releases/latest
4. Install program UIH Enumeration Extraction Agent on the host computer.

Tip: Remove the protective film from the front panel.

4. INTERCONNECTION DIAGRAM AND DISPLAY LAYOUT

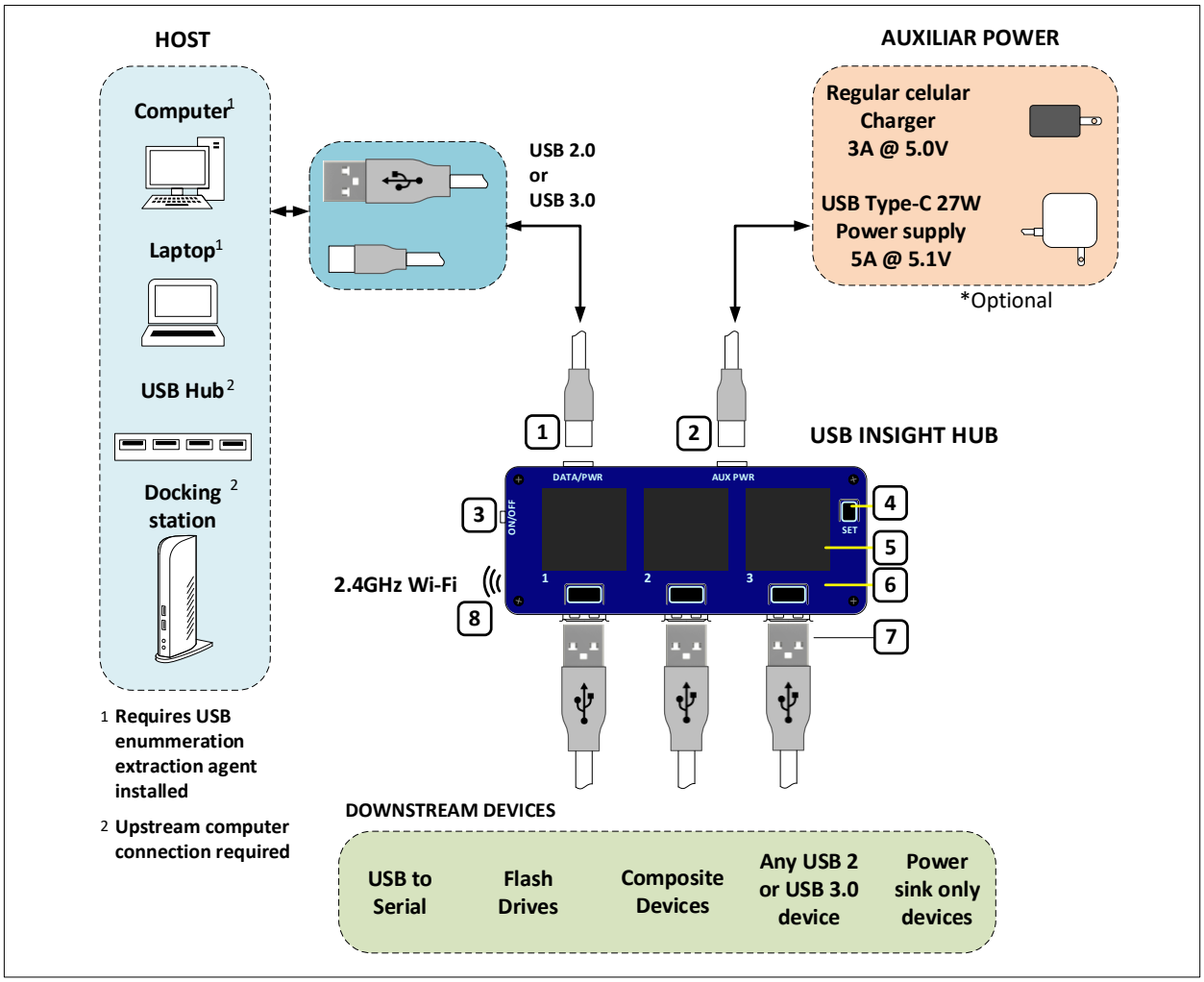


Fig. 1

1 **DATA/PWR** – USB 3.0 Type C female input connector.
Data and Power link to a host computer or USB Hub through the provided Type-C to Type-A cable or any other compatible cable. To visualize the enumeration in the displays, install the accompanying program on the host computer.

2 **AUX PWR** – USB Type C female input connector.
Use a regular cellular charger or a power supply that can provide a MAXIMUM of 5.5V DC (if the voltage is higher, the system powers down to protect downstream devices). This input serves as primary power supply, this is, if DATA/PWR and AUX PWR are connected, the first one does not draw any current.

3 **ON/OFF** – Global power toggle switch.
When pressed the system is powered (ON). In OFF position the current consumption drops to around 30uA from the active power supply.

4 **SET** – Setup button.
Press for 2 seconds to enter the configuration menu. If the configuration menu is active, pressing this button for 2 seconds exits the menu.

5 **Display** (3x) – 240x240 high IPS display.

6 **CHx Button** (3x) – Individual channel control button
Short press to toggle power ON/OFF of the corresponding channel device.
Long press to connected or disconnected USB 2.0 D+/D- data lines.

7 **CHx Type-A USB 3.0** Downstream connector (3x)
Connect to any USB 3.0 or USB 2.0 device with a maximum current drawn of 2A.
Each port has voltage and current monitoring, and protections against overcurrent (configurable), back current, short circuit and ESD events.

8 **Wi-Fi Wireless interface** – Operating as Access Point or Client.
Connect to the embedded web interface to control configure and update (OTA) the device. This functionality can be deactivated in the configuration menu if not needed.

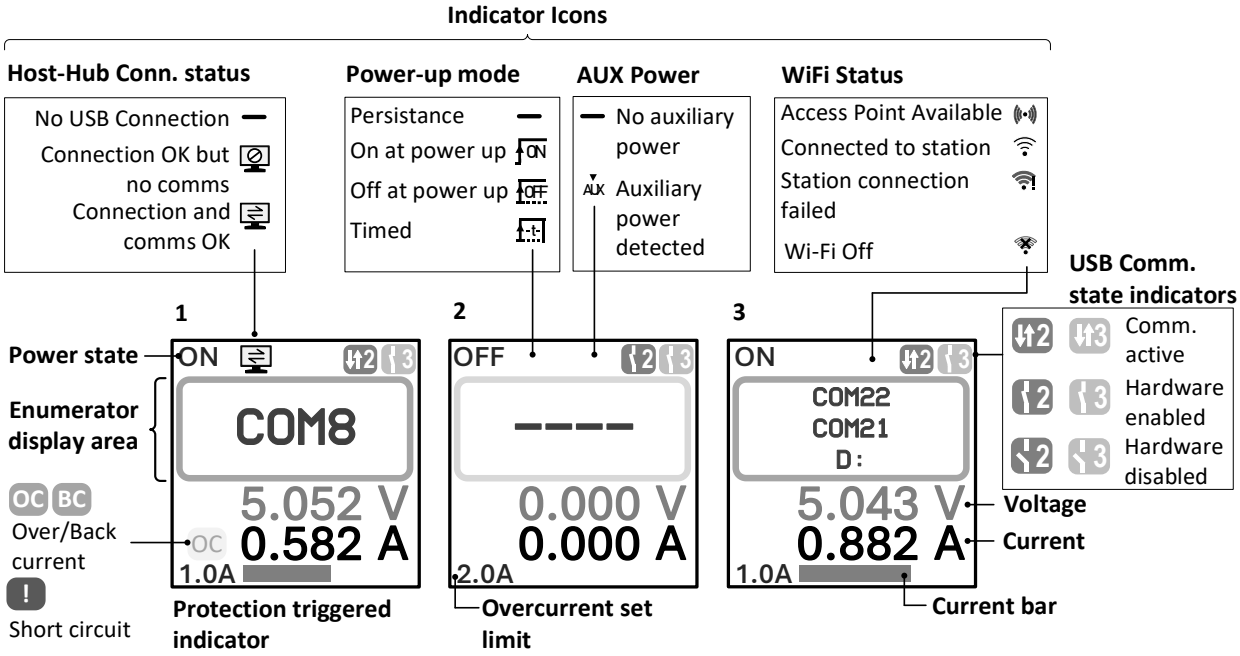


Fig. 2

5. CONFIGURATION MENU

To enter the configuration of the device, press SET button for two seconds to enter configuration Menu. Each screen displays has “soft” buttons that change according to the context. To select an option, press the corresponding individual channel control button.

Tip: If no button is pressed while in the configuration menu for 10 seconds, the interface returns to normal view. The only exception is when the WiFi info screen is active.

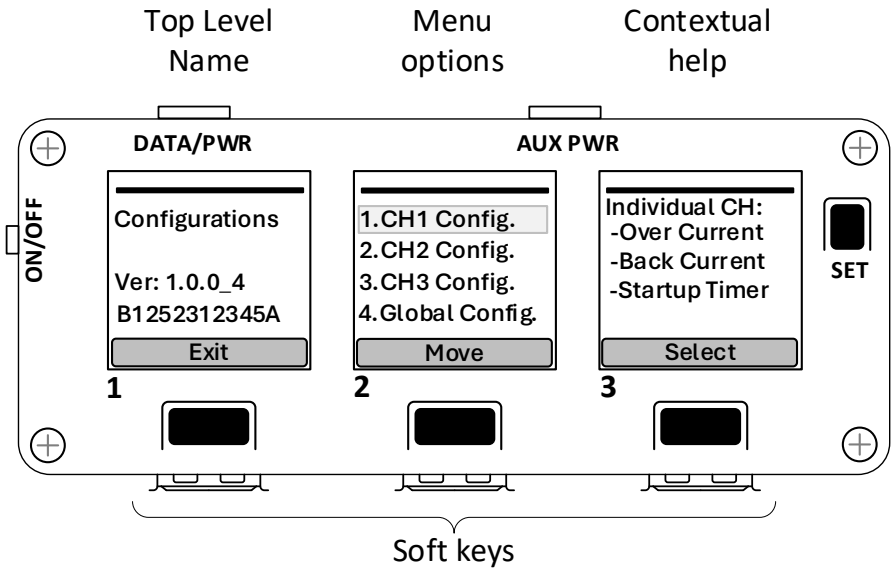


Fig. 3

6. POWER CONTROL

Each downstream port power can be controlled by a short press of the individual channel control button. Each short press toggles the power state and is displayed by the ON/OFF indicator on screen, together with a change in color from the enumerator box.

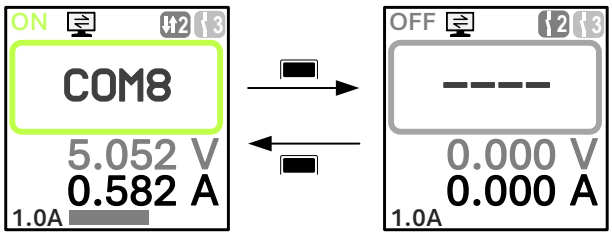


Fig. 4

7. OVERCURRENT PROTECTION

This protection turns off the power once the current from the hub to the downstream device surpasses the configured limit for more than 16ms. As this is a software, interrupt-driven protection, the reaction time can be up to 20 ms.

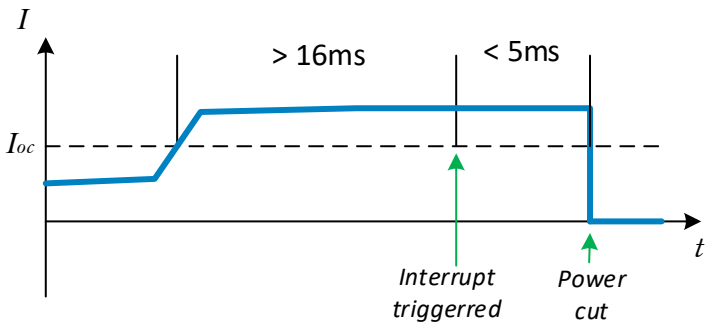


Fig. 5

The overcurrent protection limit is displayed in the bottom -right corner of the screen.

If this protection is triggered, the OC indicator is shown, enumerator box and current display change to yellow.

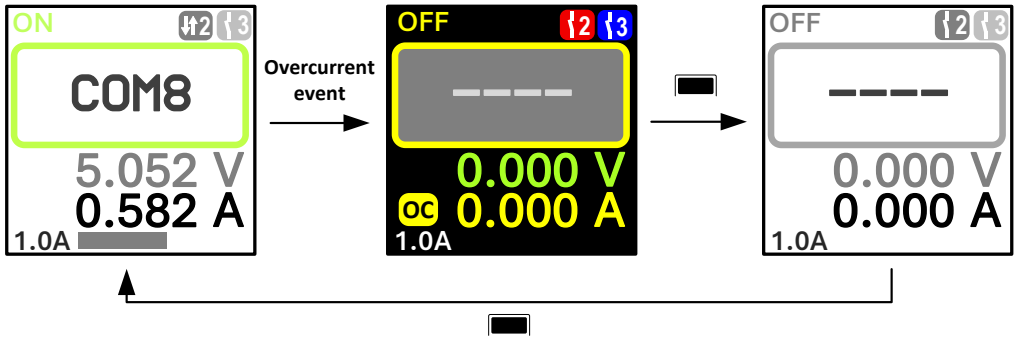


Fig. 6

To reset the protection, short press the individual channel control button twice.

To set the overcurrent limit in the configuration menu (example for channel 1):

Press SET button for two seconds to enter configuration Menu.

1. 1. CH1 Config. → 1. Over Current
2. Press Down or Up to set the limit between 100mA and 2000mA in steps of 100mA.

For a resolution of 1mA in the current limit, use the Web Interface.

8. REVERSE CURRENT PROTECTION

In the uncommon case that current flows from the downstream device to the USB hub, this protection turns off the power when the value surpasses the configured limit more than 16ms. As this is a software, interrupt-driven protection, the reaction time can be up to 20 ms.

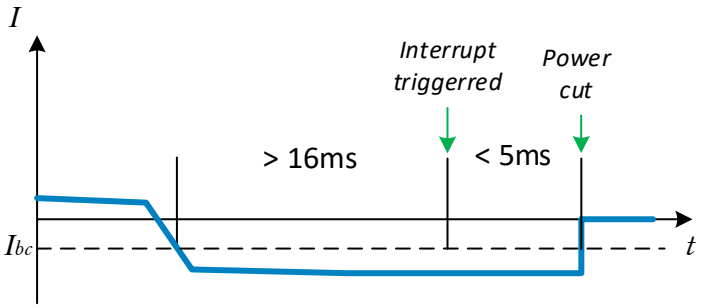


Fig. 7

If this protection is triggered, the BC indicator is displayed, enumerator box and current display change to yellow.

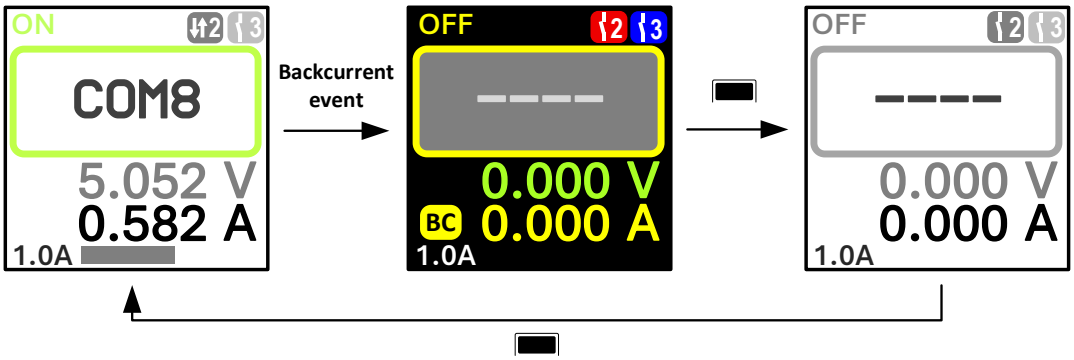


Fig. 8

To reset the protection, short press the individual channel control button twice.

To set the reverse current limit in the configuration menu (example for channel 1):

1. Press SET button for two seconds to enter configuration Menu.
2. 1. CH1 Config. → 2.Back Current
3. Press Down or Up to set the limit between 10mA and 200mA in steps of 10mA.
4. For a resolution of 1mA in reverse current limit, use the Web Interface.

Note: The electronic switch has a hardware reverse current protection with a fixed value of 320mA.

9. SHORT CIRCUIT PROTECTION

This protection is implemented by the electronic switch that controls the downstream load and the reaction time is 8ms without MCU intervention. The hardware short circuit limit has four settings: 500, 1000, 1500 and 2000 mA (configured by a resistor ladder) and is set automatically based on overcurrent protection. In this way, if the current fault ramp is too steep, the hardware protection triggers before the software one.

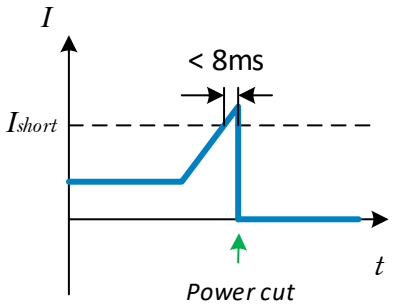


Fig. 9

If this protection is triggered, the short circuit [!] indicator is shown, enumerator box and current display change to red.

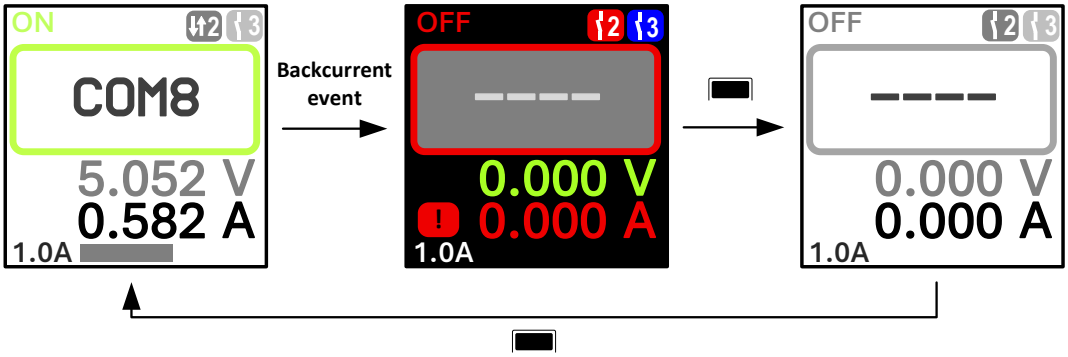


Fig. 10

To reset the protection, short press the individual channel control button twice.

10. CURRENT AND VOLTAGE MONITOR

Each channel has a voltage and current monitor with a resolution of 1mV and 1mA respectively. The current is measured with a 20mΩ high-side resistor and the voltage shown in the display is at the load side (after the shunt resistor). Expect a measurement precision of ±2%.

The meter has two configurations accessible through the configuration menu 4. Global Config. → 3. Meter:

1. Refresh rate	Refresh period of voltage and current measurements in the display.	
	1. 0.5s 2. 1.0s	- More responsive but expect more noise (10 samples) - Less responsive but less noise (20 samples)
2. Filter Type	Digital filter applied to analog measurements of voltage and current.	
	1. Moving Avg. 2. Median	Rolling average of the last 10 or 20 samples. Sort the last 10 or 20 samples and get the median filter. Faster response.

At the bottom of the screen is a current indication bar, whose full scale is the overcurrent protection limit.

11. START-UP POWER OPTIONS

USB Insight Hub has four modes to control the behavior of each channel power after boot or power up by the global power switch. To choose a mode, enter the configuration menu and navigate to: 4. Global Config. → 2. Startup Mode

11.1 Persistence mode

Each port remembers the last power state (ON or OFF) before the unit is shut down and reestablish that state after boot. This is the default mode, and no icon is shown in position 1 of display 2.

11.2 ON at start up

Independently of the last power state of each channel before the unit shut down, all channels power turns ON after boot.

Indication shown in position 1 of display 2: 

11.3 OFF at start up

Independently of the last power state of each channel before the unit shuts down, all channels power remains off after boot. Use this mode in cases that require explicit intervention from the user to power the downstream devices.

Indication shown in position 1 of display 2: 

11.4 Power-up sequence

In this mode, each channel has a delay timer to power ON after boot. The delay is configured in the configuration menu: 1. CH1 Config. → 3. Startup Timer in steps of 0.5s from 0.1s to 10.0s. Indication shown in position 1 of display 2: 

Use this mode when:

- There are one or more USB power hungry devices and you don't want all of them to be powered up at once, with the risk of triggering overcurrent protection at the upstream port or simply maintaining the stability of the power rail.
- Your test setup requires that two or more devices follow a strict order to operate correctly.

- In some scenarios the order of power up influences the enumeration assignment. A predictable sequence reduces the risk of random assignments to a device.

12. USB DATA CONTROL

12.1 USB 2 Data Switch

Each downstream port has a dedicated USB 2 communication switch, that interrupts or connects the D+/D- lines. To toggle between a connected and disconnected state, long press (more than 2 seconds) the channel control button. On the top right corner of each channel, an indicator displays the current state of the communication channels.

D+ / D-	
	The D+/D- switch is open, so no USB 2 communications are available.
	The D+/D- switch is closed, so USB 2 communications are available.
	The D+/D- switch is closed AND the enumeration extraction agent has detected the downstream device

Independent control of power and data is useful in some scenarios:

- Forcing re-enumeration of a device without removing power
- Determining the power consumption of a device without active USB communication
- Maintaining USB communication without providing power (to an externally powered USB device, for example, or a "smart" charger)

12.2 Hub mode

This feature allows you to configure the Hub to enable/disable the USB 2 or USB 3 communication lines of the Hub. The options are available from the configuration menu: 4. Global Config. → 5. Hub Mode

1. USB2 & USB3 – The hub behaves as a normal USB3.0 hub, this is, the USB 2 D+/ D- lines are connected and the USB3 input data signals are enabled.
2. USB2 Only – The hub behaves as a USB 2.0 hub, this is, USB 2 D+/ D- lines are enabled but the USB 3 data signals are disabled.
3. USB3 Only – In this case, USB2 D+/ D- lines are disabled and the USB 3 are enabled. This mode is useful when we want to force that an USB 3 compatible device (i.e a Flash drive) is connected only by USB 3.

Contrary to the USB2 data lines that can be controlled individually. USB3 Super-Speed (SS) communication lines are enabled/disabled by the Enable signal of the SS input muxer. In this case, the configuration is applied to all downstream devices.

Super Speed Comm	
	The SS input muxer is disabled. No USB 3 communications are available in all downstream ports.
	The SS input muxer is enabled. USB 3 communications are available in all downstream ports.
	The SS input muxer is enabled AND the enumeration extraction agent has detected the downstream device.

13. SCREEN OPTIONS

To access the configuration for the screen, navigate to 4. Global Config. → 4.Screen. Rotation and brightness are applied the same to the three displays

13.1 Rotation

Set the rotation of the displays (0°, 90°, 180°, 270°) to match the orientation in which the hub is located.

Note: Consider that the channels order does not change with this configuration, this is, Channel 1 is always the closest to the ON/OFF switch independently of the rotation setting.

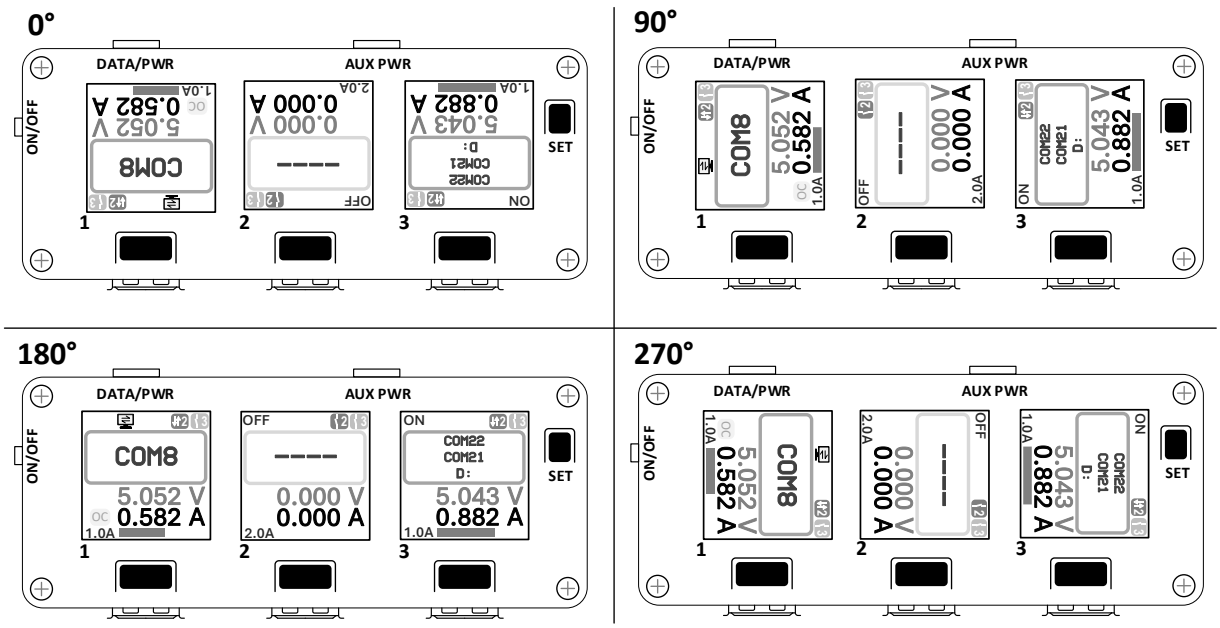


Fig. 11

13.2 Brightness

Set brightness between 5% and 100%. Default is 80%.

14. RESTORE DEFAULTS

This option is available at 4. Global Config. → 6.Restore Default and allows to set the unit back to factory defaults.

The only exception is that WiFi credentials and configurations are preserved. To also reset wireless settings, navigate to 1. WiFi → 3. WiFi Reset.

15. WIFI FUNCTIONALITY

15.1 Enable WiFi

When the indicator  or  appears in the third screen, the WiFi functionality is turned off. To Activate it:

1. Press SET button for two seconds to enter configuration Menu.
2. Navigate to 4. Global Config. → 1. Wi-Fi → 4. WiFi Enable → 2. Enable and press Select.

Note: After changing the WiFi Enable settings, the unit resets to apply the new Configuration.

After activating WiFi, the indicator will change to  (access point) or  (station mode) depending on the current configuration.

15.2 First time connection

1. Make sure that the Wi-Fi functionality is enabled. The icon  appears on the third screen.
2. Close all browser tabs before connecting to the access point, as open tabs may take limited sockets of ESP32-S3 and connection may fail.
3. On the computer, search for the access point with name ***USB-Insight-Hub-xxxxxxxxxxx***.
4. Unselect ***Connect automatically***
5. Click Connect.
6. Enter password: *usb-insight*
7. The explorer may or may not open automatically a window with the Web interface. You can access UI at IP address **192.168.4.1**.

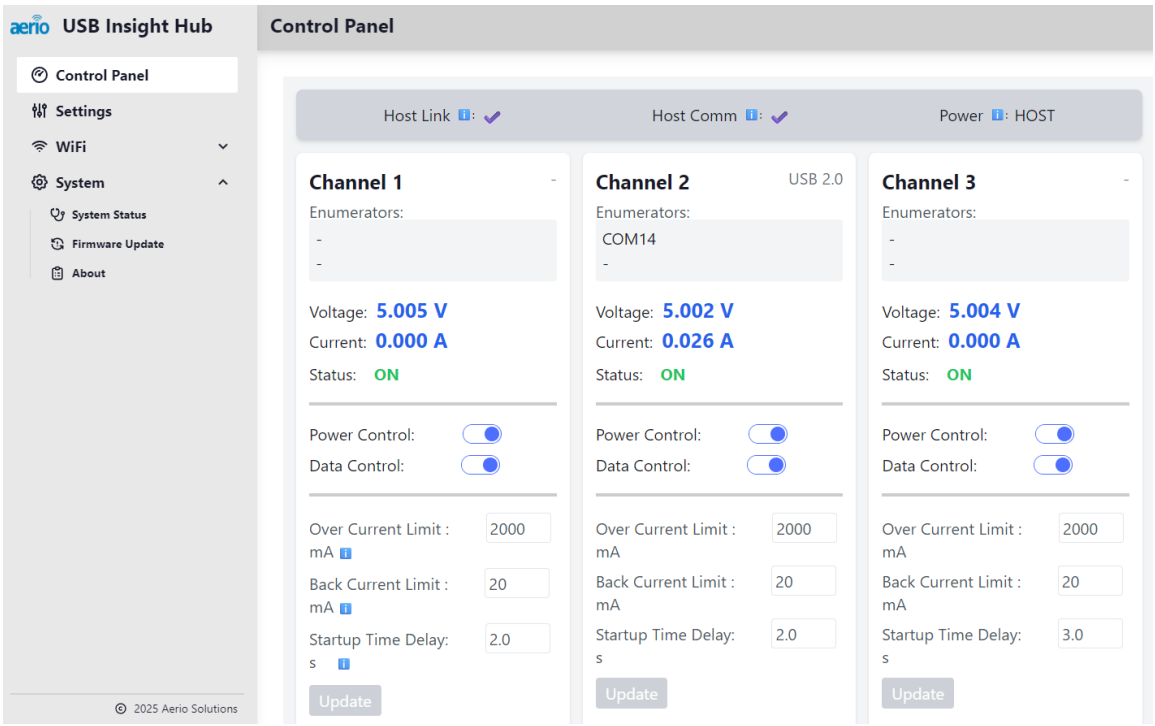


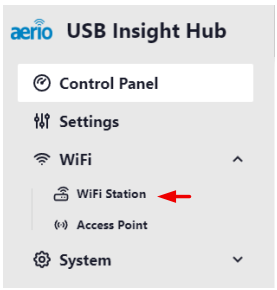
Fig. 12

Tip: The Web interface has help captions for the different controls and fields.

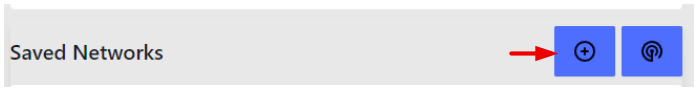
15.3 Enrolling in a wireless network

To enroll the device to your local wireless network using the Web Interface:

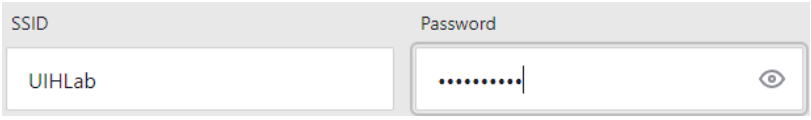
1. Make sure your computer can access the Web UI with the hub in access mode (previous step).
2. Go to WiFi → WiFi Station.



3. Select click ⊕ to add a local network



4. Enter the SSID and the password



5. Click Add Network to register it.
6. Click Apply Settings to force the USB Insight Hub to join the local wireless network.
7. If the connection to the local network is successful, the icon on screen 3 changes from to .

Note: Ther is the option to scan for available networks ( ) but is in experimental stage.

15.4 Access Web UI in your network

1. Connect your computer to the same network the USB Insight Hub is enrolled on.
2. Check the IP assigned by your network by entering the configuration menu (long SET press) and navigate to 4. Global Config. → 1. Wi-Fi → 1. WiFi Info.

Fig. 13

3. Open your browser and enter the assigned IP address (from the example 192.168.2.205).
4. Once the UI is accessible from the browser, a small arrow is shown at the side of the WiFi indicator. Also, the number of lines in the WiFi icon correspond to the signal strength.

The following table summarizes the different WiFi connection status:

	Wi-Fi is disabled. In this mode all the Wi-Fi stack is disabled completely. Credentials are conserved.
	Wi-Fi is configured as Access Point and it is available with name ***USB-Insight-Hub-xxxxxxxxxx.***
	At least one client is connected to the access point.
	The Hub is connected to a station. Each line represents the signal strength (RSSI). 3 lines: rssi > -55dB 2 lines: -55dB > rssi > -75dB 1 line: -75dB > rssi > -85dB

	No line: rssi < -85dB
	At least one client is connected to USB Insight Hub configured as station mode.
	USB Insight Hub can't connect to any of the networks that are registered (bad password, changed configuration, no signal, etc.)

15.5 Wi-Fi Recovery

This function reset the current connection and force access point. Use this function to recover the connection.

4. Global Config. → 1. Wi-Fi → 2. WiFi Recovery → 2. Recovery

15.6 Wi-Fi Reset

Use this function to erase all Wi-Fi credentials and store networks. This place the unit in factory defaults.

4. Global Config. → 1. Wi-Fi → 3. WiFi Reset → 2. Reset

16. ENUMERATION EXTRACTION AGENT

16.1 Functionality

To display the name given to the device connected to any of the downstream ports, it is necessary to install the Enumeration Extraction Agent on the host computer. This application has the following functions:

a) Identify one or more USB Insight Hub ESP32 controllers in the OS device tree.
b) Identify the corresponding enumeration information of the devices connected to each downstream.
c) Send the extracted properties to the ESP32 using the virtual serial communication link.

16.2 Windows Installation

1. Download the installer from github.com/Aeriosolutions/USB-Insight-HUB/releases/latest
2. Extract USBInsightHubAgent_Setup.exe and run it.
3. Provide permission to execute the installer.
4. Click Install

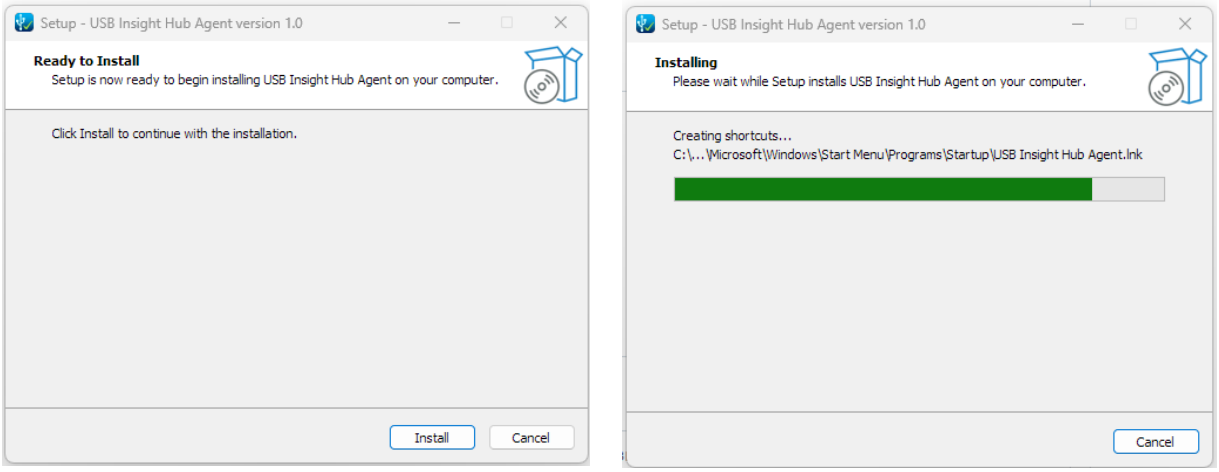


Fig. 14

5. Finish the installation

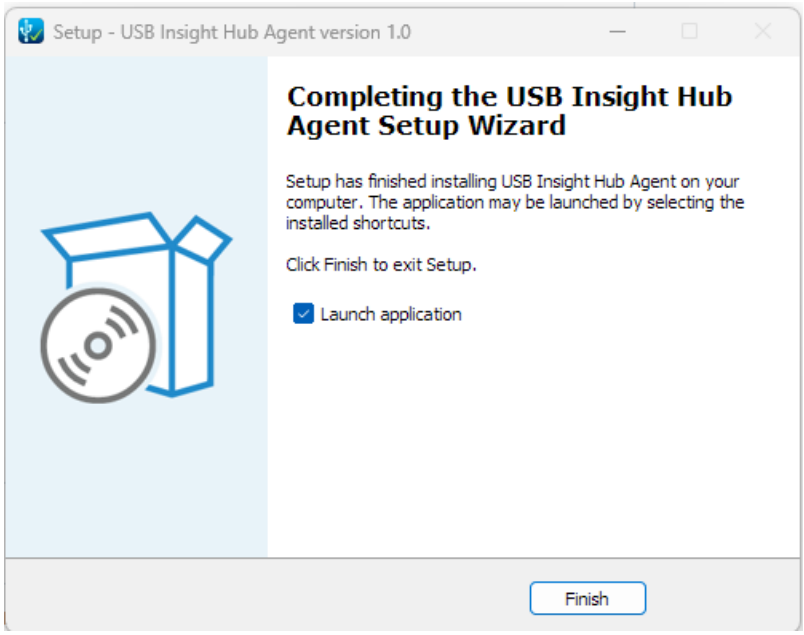
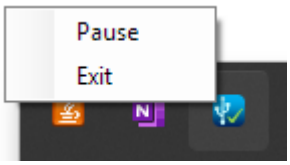


Fig. 16

16.3 Agent use

The Enumeration extraction agent runs in the background, and the only interface is though a tray icon. The application starts automatically at host computer boot.

By right clicking the tray icon, three options are available



1. **Run** – (Shown in menu if the Agent is in Pause) Resumes normal operation by connecting with any USB Insight Hubs available.
2. **Pause** – This stops and closes the serial port communication with all the USB Insight Hubs connected to the computer. Use this function if you need to connect to the ESP32 Controller of the hub from another application (i.e: Programmer, access serial API, etc.)
3. **Exit** – Stops and closes the Agent completely

Tray icon	
	Agent Running and at least one USB Insight Hub unit is connected
	Agent Running but no USB Insight Hub has been detected
	Agent Paused
No Icon	Agent is closed

The status of the connection can be verified in USB Insight Hub in position 1 of display 1.

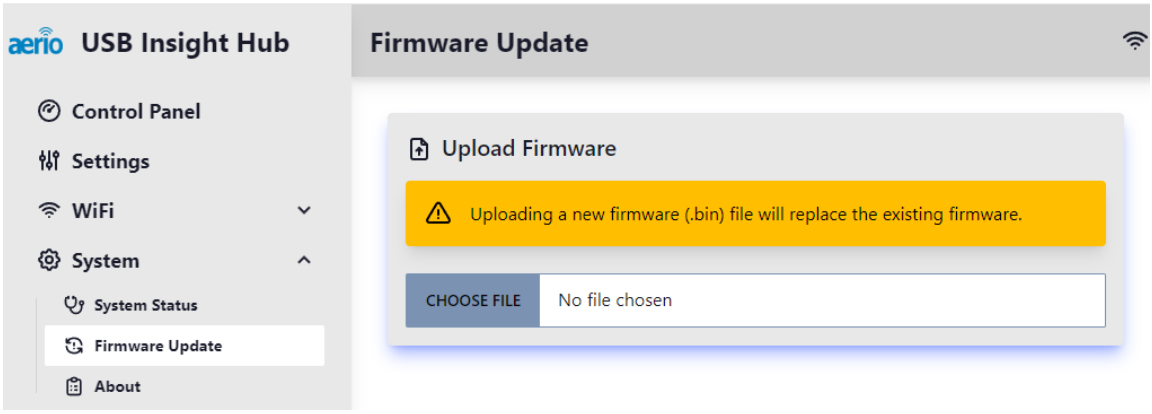
No indicator	The ESP32 and host do not have a virtual serial connection. The DATA/PWR cable is disconnected or the TinyUSB drivers are not installed in the host computer.
	The ESP32 and host have a virtual serial connection, but the port is closed, or no data transmission has been detected for more than 3 seconds.
	The ESP32 and host have a virtual serial connection and data is interchanged. This indicator must be present when the Agent is running.

17. FIRMWARE UPDATE

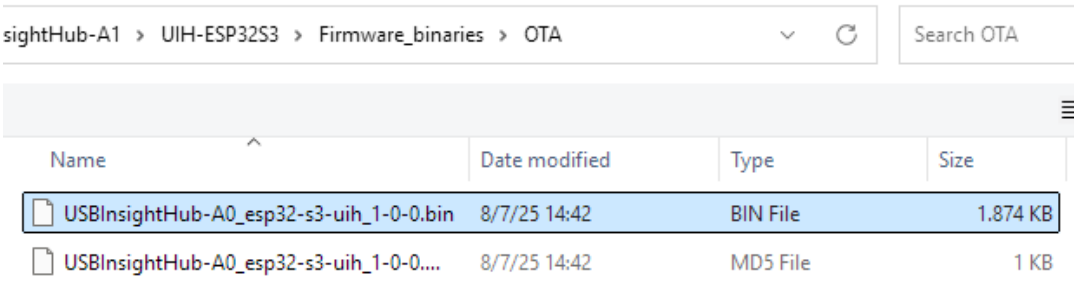
USB Insight Hub hardware can be updated by several methods. A comprehensive explanation can be found in the git repository https://github.com/Aeriosolutions/USB-Insight-HUB-Software/tree/main/USBInsightHub-A1.

The method in this guide is OTA using the Web Interface, with the limitation that only the ESP32-S3 firmware is updated, not the co-processor STM8S003K3.

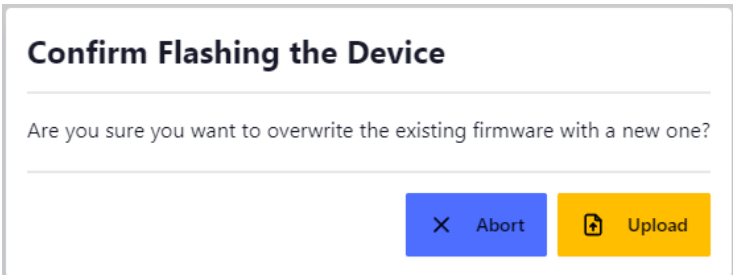
1. Make sure that you can access the web interface as explained in Chapter 16. For firmware update is recommended that the connection is as station mode.
2. In the Web interface, navigate to System -> Firmware Update



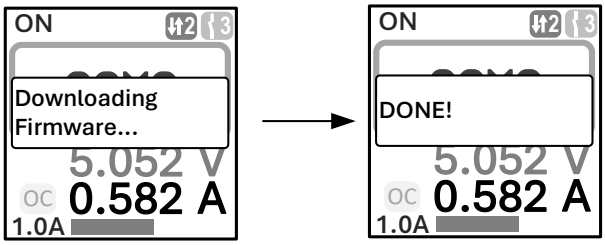
3. From the Upload Firmware form, click CHOOSE FILE
4. From the explorer folder, go to the ...\USBInsightHub-A1\UIH-ESP32S3\Firmware_binaries\OTA and select the ***.bin*** file of the firmware version that will be uploaded to the controller.



5. Confirm that you want to upland the new firmware – Click Upload



6. In the second screen of the dive a prompt shows “DOWNLOADING FIRMWARE”, and after the file has been downloaded, DONE! appears on Screen.



7. USB Insight Hub automatically boots, and a prompt with the new firmware version is displayed on the second screen.